

What is claimed is:

1. A method for determining attitude, the method comprising:
  - 5 a) transmitting signals that are modulated with a three-dimensional Doppler signature;
  - b) modulating a receiving means with a complementary three-dimensional Doppler signature, and;
  - c) interpreting the received signals to determine the attitude of said receiving means.
2. A method for determining attitude, the method comprising:
  - 10 a) transmitting a signal through a radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the transmitted signal;
  - b) receiving said transmitted signal through a receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the received signal;
  - 15 c) analyzing the relative movement of said receive means to said radiating means by interpreting said cyclic Doppler said superimposed upon the received signal, and;
  - d) determining the attitude of said receiving means based on said interpreted said cyclic Doppler.
3. A method for determining attitude, the method comprising:
  - 20 a) transmitting a signal through a radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the transmitted signal;
  - b) receiving said transmitted signal at a receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the received signal;
  - 25 c) adjusting the movement of said receiving means to bring said cyclic Doppler said superimposed upon said received signal to a predetermined value, and;
  - d) determining the attitude of said receiving means based upon the adjustment required.
4. The method of claim 3, wherein said a predetermined value of step c) is a minimum.
5. The method of claim 3, wherein said predetermine movement of said receiving means in step b) is a replica of said predetermine movement of said radiating means in step a).
6. A method for determining attitude, the method comprising:
  - 35 a) transmitting a signal through a radiating means which moves predeterminedly through three-dimensional space with known attitude, such that a cyclic Doppler is superimposed upon the transmitted signal;
  - b) receiving said transmitted signal at a receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the received signal;
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- c) analyzing said cyclic Doppler said superimposed upon said received signal to determine a Doppler pattern, and;
- d) determining the attitude of said receiving means by matching said determined Doppler pattern to pre-defined Doppler patterns associated with known relative attitudes of said radiating means and said receiving means.

7. A method for determining attitude at a user receiver configured with a first receiving means and a second receiving means, the method comprising:

- a) transmitting a signal through a radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the transmitted signal;
- b) receiving said transmitted signal at said first receiving means which moves predeterminedly through three-dimensional space, such that a first cyclic Doppler is superimposed upon the received signal;
- c) receiving said transmitted signal at said second receiving means which moves predeterminedly through three-dimensional space, and is in angular advance to said first receiving means, such that a second cyclic Doppler is superimposed upon the received signal;
- d) differencing said first cyclic Doppler and said second cyclic Doppler to determine a Doppler difference;
- e) adjusting the movement of said first receiving means and said second receiving means to minimize said Doppler difference;
- f) determining the attitude of said user receiver based upon the adjustment required.

8. A method for determining attitude at a user receiver configured with a first receiving means, a second receiving means and a third receiving means, the method comprising:

- a) transmitting a signal through a radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the transmitted signal;
- b) receiving said transmitted signal at said first receiving means which moves predeterminedly through three-dimensional space, such that a first cyclic Doppler is superimposed upon the received signal;
- c) receiving said transmitted signal at said second receiving means which moves predeterminedly through three-dimensional space, and is in angular advance to said first receiving means, such that a second cyclic Doppler is superimposed upon the received signal;
- d) receiving said transmitted signal at said third receiving means which moves predeterminedly through three-dimensional space, and is in angular advance to said second receiving means, such that a third cyclic Doppler is superimposed upon the received signal;
- e) differencing said first cyclic Doppler and said third cyclic Doppler to determine a Doppler difference;

- f) adjusting the movement of said first receiving means and said third receiving means to minimize said Doppler difference;
- g) adjusting the movement of said second receiving means to minimize said second cyclic Doppler, and;
- 5 h) determining the attitude of said user receiver based upon the adjustments required in steps f) and g).

9. A method for identifying and subsequently diminishing the effect of multipath-corrupted Doppler measurements in attitude calculations in an attitude determination system, the method comprising:

- 10 a) transmitting a signal through a radiating means which moves predeterminedly through three-dimensional space in a specified period, such that a cyclic Doppler is superimposed upon the transmitted signal;
- b) receiving said transmitted signal at a receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the received signal;
- 15 c) measuring the instantaneous signal strength of said received signal;
- d) accumulating the measurements of c) over each said specified period and processing said accumulated measurements to determine a reference signal strength;
- e) comparing said determined reference signal strength to ensuing instantaneous signal strength measurements to identify said received signals which are below a signal strength threshold, and;
- 20 f) eliminating or reducing the use of said received signals which are below a signal strength threshold from said attitude calculations.

10. A method for determining attitude at a user receiver configured with a first receiving means and a second receiving means, the method comprising:

- 25 a) transmitting a first signal through a radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the first transmitted signal;
- b) transmitting a second signal through a second radiating means which moves predeterminedly through three-dimensional space, said second signal being angularly offset from said first transmitted signal, such that a cyclic Doppler is superimposed upon the second transmitted signal;
- 30 c) receiving said first transmitted signal at said first receiving means which moves predeterminedly through three-dimensional space, such that a first cyclic Doppler is superimposed upon the first received signal;
- d) receiving said second transmitted signal at said second receiving means which moves predeterminedly through three-dimensional space, said second receiving means being angularly offset from said first receiving means, such that a second cyclic Doppler is superimposed upon the second received signal;
- 35 e) differencing said first cyclic Doppler and said second cyclic Doppler to determine a Doppler difference;

- f) adjusting the movement of said first receiving means and said second receiving means to minimize said Doppler difference, and;
- g) determining the attitude of said user receiver based upon the adjustment required.

5     **11.**     A method for determining attitude, the method comprising:

- a) transmitting a plurality of signals from a plurality of spatially distributed transmission means configured with at least one or more radiating means, said radiating means configured to move through three-dimensional space with identical predefined motion, with each of said plurality of signals assigned to one of said radiating means, such that an identical cyclic Doppler is superimposed upon each transmitted signal;
- 10     b) receiving said plurality of transmitted signals at a receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the received signal;
- 15     c) adjusting the movement of said receiving means to bring said cyclic Doppler said superimposed upon the received signal to a predetermined value, and;
- d) determining the attitude of said receiving means based upon the adjustment required.

20     **12.**     A method for determining attitude without using receiver carrier tracking loops, the method comprising:

- a) transmitting a signal through a radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the transmitted signal;
- 25     b) receiving said transmitted signal at a receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the received signal;
- c) deriving Doppler measurements from the instantaneous phase of said received signal;
- d) adjusting the movement of said receiving means to bring said derived Doppler to a predetermined value, and;
- 30     e) determining the attitude of said receiving means based upon the adjustment required.

**13.**     A method for creating a signal that manifests a three-dimensional synthesized phase centre movement, the method comprising:

- 35     a) deploying a plurality of spatially distributed antenna elements, each antenna element being connected to a variable gain means, each said variable gain means being responsive to a control means, and with all said variable gain means connected to a common transmission or reception means;
- b) regulating said control means to vary the gain distribution between antenna elements whilst transmitting or receiving a signal,

40     such that the phase centre of the transmitted or received signal is physically displaced in three-dimensions.

14. A device for creating a signal that manifests a three-dimensional synthesized phase centre movement, the device comprising a plurality of spatially distributed antenna elements, each antenna element being connected to a variable gain means, each said variable gain means being responsive to a control means,  
5 and with all said variable gain means connected to a common transmission or reception means.

15. A method for determining attitude at a user receiver configured with a first receiving means and a second receiving means, the method comprising:

- 10 a) transmitting a first signal through a first radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the first transmitted signal;
- b) transmitting a second signal, which is chronologically synchronous to said first transmitted signal, through a static radiating means which is in close proximity to said first radiating means;
- 15 c) receiving said first transmitted signal at said first receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the first received signal;
- d) receiving the second transmitted signal at said second receiving means which is in close proximity to said first receiving means;
- 20 e) measuring the Doppler of the signals received at said first receiving means and said second receiving means and differencing said Doppler measurements to determine a Doppler difference;
- f) adjusting the movement of said first receiving means to minimize said Doppler difference, and;
- g) determining the attitude of said user receiver based upon the adjustment required.

25 16. A method for determining attitude in a user receiver configured with an Inertial Navigation System (INS), the method comprising:

- a) transmitting a signal through a radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the transmitted signal;
- 30 b) receiving said transmitted signal at a receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the received signal;
- c) determining said user receiver movement Doppler from said Inertial Navigation System (INS);
- d) differencing said cyclic Doppler said superimposed upon the received signal and said user receiver movement Doppler from said Inertial Navigation System (INS) to determine a Doppler difference;
- 35 e) adjusting the movement of said receiving means to minimize said Doppler difference, and;
- f) determining the attitude of said user receiver based upon the adjustment required.

17. A method for determining attitude, the method comprising:
- a) transmitting a signal through a radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the transmitted signal;
  - 5 b) receiving said transmitted signal through a receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the received signal;
  - c) filtering said received signal to remove low-frequency user-movement Doppler and hence establish a residual cyclic Doppler;
  - d) adjusting the movement of said receiving means to bring said established residual cyclic Doppler to  
10 a predetermined value, and;
  - e) determining the attitude of said receiving means based upon the adjustment required.
18. A method for identifying and subsequently diminishing the effects of multipath corruption in signals used by attitude calculating means in a user receiver, said user receiver configured with a first receiving  
15 means and a second receiving means, the method comprising:
- a) transmitting a first signal through a first radiating means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the first transmitted signal;
  - 20 b) transmitting a second signal, through a second radiating means which moves predeterminedly through three-dimensional space, said second signal being angularly offset from said first transmitted signal, such that a cyclic Doppler is superimposed upon the second transmitted signal;
  - c) receiving said first transmitted signal at said first receiving means which moves predeterminedly through three-dimensional space, such that a cyclic Doppler is superimposed upon the first received  
25 signal;
  - d) receiving said second transmitted signal at said second receiving means which moves predeterminedly through three-dimensional space, said second receiving means being angularly offset from said first receiving means, such that a cyclic Doppler is superimposed upon the second received signal;
  - 30 e) measuring the instantaneous signal strength of said first received signal;
  - f) measuring the instantaneous signal strength of said second received signal;
  - g) processing measurements obtained at steps e) and f) to determine a low signal strength level which indicates multipath corrupted signals; and,
  - h) configuring said attitude calculating means to preferentially use signals stronger than the level  
35 determined in g).